

DRS

Our Ref.: 2018-460  
57974-US-AK/mo

# ***U.S. PATENT APPLICATION***

***Inventor(s):*** Yoshiyuki MAKI  
Masaya OI  
Tsukasa KIMEZAWA

***Invention:*** VEHICULAR CONTROL DEVICE HAVING SELF-DIAGNOSIS  
FUNCTION AND SELF-DIAGNOSIS PROGRAM FOR IMPLEMENTING  
THE SAME

***NIXON & VANDERHYE P.C.  
ATTORNEYS AT LAW  
1100 NORTH GLEBE ROAD  
8<sup>TH</sup> FLOOR  
ARLINGTON, VIRGINIA 22201-4714  
(703) 816-4000  
Facsimile (703) 816-4100***

## ***SPECIFICATION***

**VEHICULAR CONTROL DEVICE HAVING SELF-DIAGNOSIS FUNCTION  
AND SELF-DIAGNOSIS PROGRAM FOR IMPLEMENTING THE SAME**

**CROSS REFERENCE TO RELATED APPLICATION**

5           This application is based on and incorporates herein by reference Japanese Patent Application No. 2000-329026 filed on October 27, 2000.

**BACKGROUND OF THE INVENTION**

1. Field of the Invention:

10           The present invention relates to a self-diagnosis function of a vehicular control device that controls a vehicle and also relates to a technique for implementing the self-diagnosis function through an object oriented program.

2. Description of Related Art:

15           Recently, the mechatronics technology, which combines the mechanics technology with the electronics technology, has shown the notable progress as a result of the substantial progress in the electronics technology, such as the advent of high performance microprocessors. As a part of the progress in the  
20           mechatronics technology, various computer systems have been developed for use in vehicles, such as automobiles. These vehicular computer systems are used to achieve an improvement in resource consumption, energy consumption, running performance, safety, comfort or the like and are provided in  
25           various systems, such as an engine system, a drive system, a running/safety system, an entertainment system and the like of the vehicle.

Among the various computer systems, there is a particularly strong demand for a vehicle controlling computer system to achieve high reliability. For example, if the vehicle controlling computer system is not able to detect a malfunction of a particular component of the system, the vehicle may experience a driving trouble or may not be able to continue its driving. To avoid this, one previously proposed computer system has a self-diagnosis function to improve its reliability. Specifically, a diagnosis process is implemented to achieve the self-diagnosis function. In the diagnosis process, operations of a computer unit, various sensors and the like are automatically and periodically checked. Then, if any malfunction is detected, a corresponding malfunction indicator light (MIL) is lighted or flashed to notify a user of the malfunction, and a malfunction code (DTC) is stored in a memory to notify a service person of a damaged component corresponding to the malfunction code. Targets of the diagnosis process include a crank angle sensor, a cam angle sensor, a water temperature sensor and the like. The number of the targets of the diagnosis process reaches about 200 or more. Hereinafter, the targets of the diagnosis process will be simply referred to as "the diagnosis targets".

The present invention relates to an MIL control operation for controlling the MILs in the diagnosis process. The malfunction notification through the MILs provides the user with systematic malfunction information of about 200 or more diagnosis targets through several MILs. Thus, in the MIL control

operation, it is essential to provide logic for systematically interpreting and judging malfunction information transmitted from each one of the diagnosis targets.

One previously proposed technique for implementing such a diagnosis process is disclosed, for example, in Japanese Unexamined Patent Publication No. 7-190897 (corresponding to U.S. Patent No. 5,671,141). In this publication, there is disclosed a program architecture including an MIL controller module that illuminates the MIL when a predetermined number of malfunctions are detected.

The MIL controller module disclosed in the above publication illuminates the MIL when the predetermined number of malfunctions are detected. Furthermore, (I) malfunction judgment of the diagnosis target, (II) adjustment of the result of each malfunction judgment and (III) an MIL control operation that is carried out based on a result of the adjustment are conducted by the single MIL controller module. Thus, when specification change, such as change of a diagnosis target, takes place, a relatively large amount of time is required to modify the MIL controller module. This will be further described in the following (1)-(3).

(1) The malfunction judgment (I) of the diagnosis target cannot be a simple process of checking an operational state of the diagnosis target from time to time to judge or determine whether the diagnosis target is malfunctioning. This is due to the fact that each malfunction has a particular level. For example, in a case of "a malfunction" of an input-signal line

connected to a sensor, a temporal loose connection of, for example, a connector is called "the malfunction", and complete disconnection of the signal line is also called "the malfunction". In the former case, the connector could resume its normal function later on and thereby may not be required to be replaced. Thus, in light of the above fact, in one previously proposed technique, the temporal malfunction, such as the loose connection of the connector, is referred to as "temporarily abnormal", and the permanent malfunction, such as the complete disconnection of the signal line, is referred to as "abnormal". The malfunction information that indicates such a level of malfunction is stored in a memory. Then, the MIL control operation is carried out based on such malfunction information, so that flashing, lighting-on or lighting-off of the MIL is generally conducted based on the level of the malfunction.

Furthermore, even if the malfunction information is the same, that is, the level of the malfunction is the same, the MIL control operation may vary from one diagnosis target to another diagnosis target. That is, for example, if the diagnosis target is the important one and is determined to be temporarily abnormal, the MIL should be lighted on or flashed immediately. On the other hand, if the diagnosis target is not the important one and is determined to be temporarily abnormal, the MIL may not be lighted on or flashed immediately until the diagnosis target becomes completely abnormal.

Thus, even if the malfunction information is determined in view of the malfunction level of the diagnosis target, the

control operation of the MIL varies depending on the type of the diagnosis object. Thus, the logic for executing the adjustment (II) of the result of each malfunction judgment may be complicated.

5            Particularly, the previously proposed MIL controller module is constructed to carry out the series of the processes (I)-(III) at once. Thus, when anyone of the diagnosis targets is changed, the logic for executing the malfunction judgment (I) of the diagnosis target and the logic for executing the adjustment (II) of the result of the malfunction judgment need to be changed, so that a relatively large amount of time may be required to change the MIL controller module.

10  
15            (2) The MIL controller module disclosed in the above publication is operated upon receiving a command from a scheduler. That is, the series of the processes (I)-(III) are carried out upon receiving the command from the scheduler.

20            A timing for executing the malfunction judgment (I) of the diagnosis target varies depending on the diagnosis target. For example, a malfunction of one diagnosis target may be judged at predetermined time intervals, e.g., at every 4 ms, 8 ms or 16 ms. A malfunction of another diagnosis target may be judged at predetermined crank angles (CA), e.g., at every 30 CA, 60 CA or 180 CA. Furthermore, a timing for executing the MIL control operation (III) does not coincide with the timing for executing the malfunction judgment (I) of the diagnosis target.

25            Since the series of the processes (I)-(III) are conducted sequentially in the previously proposed MIL controller module,

the timing for executing the MIL control operation (III) needs to be adjusted in view of the timing for executing the malfunction judgment (I) of the diagnosis target. If any diagnosis target needs to be changed, this will constitute a factor that lengthens the time required for changing the MIL controller module.

(3) Furthermore, the logic for executing the MIL control operation (III) is constructed to control the MIL based on the result of the adjustment and to provide a final control instruction for instructing a control operation of the corresponding MIL, such as flashing, lighting-on or lighting off, based on vehicle information. Thus, the logic for executing the MIL control operation (III) is generally not dependent on the type of diagnosis target and is generally not required to be changed when the diagnosis target is changed. On the other hand, when the vehicle information is changed, only the logic for executing the MIL control operation (III) is required to be changed.

However, since the MIL controller module disclosed in the above publication is modularized to conduct the series of the processes (I)-(III), so that reusability of the MIL controller module is relatively low.

A reusable program structure for executing the malfunction judgment (I) of the diagnosis target has been disclosed in Japanese Patent Application No. 2000-130180 (corresponding to U.S. Patent Application No. 09/840,877), which is incorporated herein by reference. Thus, the present invention is particularly

focused on modularization of logic for executing the adjustment (II) of the result of each malfunction judgment and logic for executing the MIL control operation (III) conducted based on the result of the adjustment.

5

#### SUMMARY OF THE INVENTION

The present invention addresses the disadvantages discussed in the above sections (1)-(3), and it is an objective of the present invention to improve reusability of a self-diagnosis program that implements an MIL control operation in a case of specification change, such as change of a diagnosis target.

To achieve the objective of the present invention, there is provided a vehicular control device having a self-diagnosis function for informing occurrence of abnormality in at least one diagnosis target by controlling at least one malfunction indicator light (MIL) based on a result of a malfunction detection operation of each one of the at least one diagnosis target. The vehicular control device has an object oriented self-diagnosis program stored therein for implementing the self-diagnosis function. The object oriented self-diagnosis program includes at least one malfunction-information storing object and a malfunction-information managing object. The at least one malfunction-information storing object specifies a control instruction for instructing a control operation of the at least one MIL with respect to malfunction information of the each one of the at least one diagnosis target based on the



malfunction information of the each one of the at least one diagnosis target. The malfunction information of the each one of the at least one diagnosis target is determined based on the result of the malfunction detection operation of the each one of the at least one diagnosis target in view of a level of malfunction of the each one of the at least one diagnosis target. The malfunction-information managing object carries out adjustment of the control instruction of the at least one MIL specified by the at least one malfunction-information storing object based on the malfunction information of the each one of the at least one diagnosis target and outputs MIL information for controlling the at least one MIL based on a result of the adjustment of the control instruction of the at least one MIL.

In place of the above object oriented self-diagnosis program, there may be provided an object oriented self-diagnosis program including a malfunction-information managing object that outputs MIL information for controlling the at least one MIL when a request for controlling the at least one MIL is received. The request for controlling the at least one MIL is different from a request for executing the malfunction detection operation of the each one of the at least one diagnosis target.

Also, in place of the above object oriented self-diagnosis program, there may be provided an object oriented self-diagnosis program including a malfunction-information managing object that outputs MIL information for controlling the at least one MIL, and an MIL controlling object for controlling the at least one MIL based on the MIL information outputted from the

malfunction-information managing object.

Furthermore, in place of the above object oriented self-diagnosis program, there may be provided an object oriented self-diagnosis program including at least one malfunction-information storing object that stores malfunction information of the each one of the at least one diagnosis target determined based on the result of the malfunction detection operation of the each one of the at least one diagnosis target in view of a level of malfunction of the each one of the at least one diagnosis target, and a malfunction-information managing object that commands the at least one malfunction-information storing object to store the malfunction information of the each one of the at least one diagnosis target based on the result of the malfunction detection operation of the each one of the at least one diagnosis target. The malfunction-information managing object may output MIL information for controlling the at least one MIL based on the malfunction information of the each one of the at least one diagnosis target stored by the at least one malfunction-information storing object. The object oriented self-diagnosis program may further include an MIL controlling object for controlling the at least one MIL based on the MIL information outputted from the malfunction-information managing object.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with additional objectives, features and advantages thereof, will be best understood from

the following description, the appended claims and the accompanying drawings in which:

FIG. 1 is a schematic view of an engine control system according to an embodiment of the present invention;

5        FIG. 2 is a block diagram showing a structure of an engine control unit of the engine control system according to the embodiment;

FIG. 3 is a schematic view showing a structure of a self-diagnosis program;

10        FIG. 4 is a MSC showing a procedure of MIL control operation;

FIG. 5 is a schematic view showing information stored by each malfunction-information storing object;

FIG. 6 is a flowchart showing an MIL response process;

15        FIG. 7 is a flowchart showing an MIL information output process; and

FIG. 8 is a flowchart showing a control instruction output process.

20

#### DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the present invention will be described with reference to the accompanying drawings.

25

FIG. 1 is a diagram showing an entire structure of an engine control system. The engine control system includes an engine 11 and an engine control unit 16 that controls the engine 11. The engine control unit 16 corresponds to "a vehicular control device" of the present invention.

Intake air is supplied to the engine 11 from an air cleaner through an intake air pipeline 12. An air flow sensor 13 for measuring an intake air flow and an intake air temperature sensor 14 for measuring an intake air temperature are provided in the intake air pipeline 12. Furthermore, a throttle valve 15 driven by an accelerator pedal is provided in the intake air pipeline 12.

The engine control unit 16 receives various signals indicative of a state of the engine 11. These signals include an intake air flow signal of the air flow sensor 13 indicative of an intake air flow, a throttle valve position signal of a throttle sensor 17 indicative of a throttle valve position of the throttle valve 15, an air-fuel ratio (A/F) signal of an air-fuel ratio sensor 18 indicative of an oxygen concentration in exhaust gas, a battery voltage signal of a battery 19, a water temperature signal of a water temperature sensor 20, a rotational angle signal of a distributor 21 that is driven by the engine 11 and a cylinder identification signal of the distributor 21.

The engine control unit 16 controls an operation of the engine 11. Specifically, the engine control unit 16 computes a fuel injection amount of each cylinder of the engine 11 in consistent with the current state of the engine 11 based on the above signals and outputs a fuel injection signal to each injector 22a, 22b, 22c, 22d provided to each corresponding cylinder. Furthermore, the engine control unit 16 outputs an ignition signal to an igniter 23.

The engine control unit 16 also diagnoses various

components of the vehicle based on sensor signals outputted from corresponding sensors. A test switch 24 is provided to the engine control unit 16. The test switch 24 is provided for setting a diagnosis mode for outputting a result of the diagnosis. A malfunction indicator light (MIL) 25 for indicating the result of the diagnosis is connected to the engine control unit 16.

A switch 26 is an ignition switch that connects the battery 19 to the engine control unit 16. A starter switch 28 is provided for controlling a starter motor 27 in a synchronous manner with respect to the ignition switch 26.

Next, the engine control unit 16 will be described in greater detail. FIG. 2 is a block diagram showing a structure of the engine control unit 16 shown in FIG. 1. The engine control unit 16 includes a CPU 31 that constitutes a computer system. The CPU 31 receives data from both an analog input circuit 32 and a digital input circuit 33. Analog data from the analog input circuit 32 are converted to digital data through an A/D converter 34 and are then supplied to the CPU 31.

The analog input circuit 32 receives the sensor signal  $U_s$  of the air flow sensor 13, the sensor signal  $Th_w$  of the water temperature sensor 20, the sensor signal  $Th_a$  of the intake air temperature sensor 14 and the voltage +B of the battery 19. The digital input circuit 33 receives the cylinder identification signal G1 of the distributor 21, the rotational angle signal  $Ne$  of the distributor 21, a lean rich signal  $Ox$  of the air-fuel ratio sensor 18 indicative of the oxygen concentration, the sensor signal  $STO$  of the throttle sensor 17 indicative of the throttle

valve position of the throttle valve 15, a start signal STA of the starter switch 28 and a signal T of the test switch 24 for setting the diagnosis mode.

5 The A/D converter 34 acts like a mutiplexer that sequentially selects and reads the sensor signals inputted to the analog input circuit 32 upon receiving corresponding commands from the CPU 31 and converts the sensor signals to the corresponding digital data.

10 The power supply circuit 35 supplies the voltage +B of the battery 19 to the CPU 31 through the ignition switch 26. The power supply circuit 35 also provides a continuous backup power source Batt.

15 Output data from the CPU 31 are supplied to output circuits 36, 37, 38 and are then outputted from the output circuits 36, 37, 38 as output signals of the engine control unit 16. That is, the output circuit 36 outputs the ignition signal IGt to the igniter 23. The output circuit 37 outputs a signal W indicative of the result of the diagnosis to control the MIL 25. The output circuit 38 outputs an output signal Tq. The output signal Tq  
20 specifies the fuel injection amount corresponding to the operational state of the engine 11 and is outputted to each injector 22a-22d to vary the injection amount of each injector 22a-22d.

25 The CPU (engine control unit) 31 includes a memory 39 for storing an object oriented self-diagnosis program which will be described in greater detail below. The memory 39 includes a ROM and one of a standby RAM and a nonvolatile EEPROM. The standby

RAM is supplied with the electric power to keep the data stored therein even when the ignition switch 26 is turned off. The self-diagnosis program is stored in the ROM. The standby RAM or the EEPROM stores the malfunction information that is provided when the self-diagnosis program is executed.

A characteristic feature of the present embodiment is found in the self-diagnosis program stored in the ROM of the memory 39. Thus, the self-diagnosis program will now be described in greater detail.

FIG. 3 is a schematic diagram showing an architecture of the self-diagnosis program. The self-diagnosis program includes a plurality of programs, each having an object-oriented design. As is well known in the art, the object-oriented design is different from a previously proposed design in which a software is focused on a process (e.g., a process of fuel injection). In the object-oriented design, modeling is carried out using an object as a basic unit, and each process is described based on characteristics and behavior of the corresponding object. This basic unit is referred to as "object". The program that has the object-oriented design is constructed using the objects as its minimum constituent units. During execution of the program, a series of processes are executed while messages transmitted between the objects are used to connect between the objects. Each object includes data (attribute) and a method (procedure) for processing the data. The method of one object is executed upon receiving the corresponding message from the other object. In this description, although each object conducts a corresponding

action by itself (e.g., the object detects a malfunction), it will be understood that the action is actually carried out when the CPU 31 executes the corresponding program.

As shown in FIG. 3, the self-diagnosis program of the present embodiment includes malfunction detecting objects 100, a malfunction-information managing object 200, malfunction-information storing objects 300 and an MIL controlling object 400. In FIG. 3 as well as in the other drawings, each object is designated as "OBJ" for the sake of simplicity.

The objects 100-400 are programs implemented on a platform (hereinafter, simply referred as "PF") 500 and are executed upon receiving an MIL malfunction detection request (or simply referred to as "MALFUNC.DETECT.REQ.") or an MIL state renewal request (or simply referred to as "MIL STATE RENEW.REQ.") from the PF 500.

When each malfunction detecting object 100 receives the malfunction detection request from the PF 500, the malfunction detecting object 100 detects a malfunction of a corresponding diagnosis target to be diagnosed by the self-diagnosis based on the information, such as information of a corresponding sensor inputted to the engine control unit 16. Each malfunction detecting object 100 is provided for each corresponding malfunction detecting process. The PF 500 outputs the malfunction detection request at a predetermined timing that is determined depending on the diagnosis target. For example, the PF 500 may output the malfunction detection request to the corresponding malfunction detecting object 100 at predetermined



time intervals, e.g., at every 4 ms, 8 ms or 16 ms. Alternatively, the PF 500 may output the malfunction detection request to the corresponding malfunction detecting object 100 at predetermined crank angles (CA), e.g., at every 30 CA, 60 CA or 180 CA.

5           The malfunction-information managing object 200 receives normal/abnormal notification from each malfunction detecting object 100. Then, the malfunction-information managing object 200 sends a malfunction-information (or simply referred to as "MALFUNC-INFO.") storing notification to the corresponding malfunction-information storing object 300. When the malfunction-information storing object 300 receives the malfunction-information storing notification, the malfunction-information storing object 300 stores the malfunction information. The malfunction-information storing object 300 is provided for each predetermined malfunction check item. As described above, the malfunction detection request transmitted from the PF 500 acts as a trigger for generating the malfunction information, such as "normal", "temporarily abnormal" or "abnormal", and the malfunction information is stored for each malfunction check item corresponding to the diagnosis target.

20           When the MIL controlling object 400 receives the MIL state renewal request from the PF 500, the MIL controlling object 400 sends an MIL information request (or simply referred to as "MIL INFO.REQ.") to the malfunction-information managing object 200. The PF 500 outputs the MIL state renewal request at a predetermined timing that is appropriate for controlling the MIL

25.

When the malfunction-information managing object 200 receives the MIL information request from the MIL controlling object 400, the malfunction-information managing object 200 requests each malfunction-information storing object 300 to retrieve a stored control instruction for instructing a control operation of the MIL 25 (hereinafter, referred to as the control instruction of the MIL 25) corresponding to the stored malfunction information. Upon receiving the request, the malfunction-information storing object 300 outputs the control instruction (or simply referred to as "CONT.INST.") of the MIL 25 corresponding to the stored malfunction information based on the stored malfunction information. Then, the malfunction-information managing object 200 outputs the MIL information for controlling the MIL 25 to the MIL controlling object 400 based on the control instruction received from each malfunction-information storing object 300.

Then, the MIL controlling object 400 outputs an MIL response to the PF 500 based on the MIL information from the malfunction-information managing object 200 and also based on vehicle information.

That is, in the present embodiment, the MIL control operation is achieved by the process, which is triggered by the MIL state renewal request and is carried out separately from the process triggered by the malfunction detection request.

Connections between the objects 200-400 in the MIL control operation will be described in greater detail with reference to

a message sequence chart (hereinafter, referred to as "the MSC").

FIG. 4 is the MSC depicting procedure of the MIL control operation.

First, the PF 500 outputs the MIL state renewal request to the MIL controlling object 400. Upon receiving the MIL state renewal request from the PF 500, the MIL controlling object 400 carries out an MIL response process S1. In the MIL response process S1, the MIL information request is outputted to the malfunction-information managing object 200.

Upon receiving the MIL information request, the malfunction-information managing object 200 carries out an MIL information output process S2. In the MIL information output process S2, a control instruction retrieving request is outputted to each malfunction-information storing object 300.

Upon receiving the control instruction retrieving request, each malfunction-information storing object 300 carries out a control instruction output process S3. In the control instruction output process S3, the corresponding control instruction is specified and is outputted based on the stored malfunction information. Thus, each malfunction-information storing object 300 includes relationship information indicative of the relationship between the malfunction information and the corresponding control instruction. The control instructions mentioned above include three control instructions, namely, "flashing" (or simply referred to as "FLASH."), "lighting-on" (or simply referred to as "ON") and "lighting-off" (or simply referred to as "OFF") of the MIL.

In the MIL information output process S2 of the malfunction-information managing object 200, when the control instruction is outputted from all the malfunction-information storing objects 300, the MIL information is prepared and is outputted based on the control instructions outputted from all the malfunction-information storing objects 300.

When the MIL information is outputted from the malfunction-information managing object 200, the MIL controlling object 400 sends the MIL response to the PF 500 based on the vehicle information. In this way, the state of the MIL 25 is actually renewed.

Next, with reference to FIG. 5, a relationship between the malfunction information and the control instruction stored by the corresponding malfunction-information storing object 300 will be described.

Each malfunction-information storing object 300 is provided for each malfunction check item, as mentioned above. In the present embodiment, a malfunction-information name used for storing the malfunction information is provided for each malfunction check item in a one-to-one relationship. That is, the unique malfunction-information name is provided to each malfunction-information storing object 300. For example, with reference to FIG. 5, a malfunction-information storing object 310 has the malfunction-information name of "AIR FLOW SHEET", and a malfunction-information storing object 320 has the malfunction-information name of "WATER TEMPERATURE SHEET" (or simply referred to as "WATER TEMP.SHEET"). Similarly, a

malfunction-information storing object 330 has the malfunction-information name of "INTAKE AIR TEMPERATURE SHEET" (or simply referred to as "AIR TEMP.SHEET"), and a malfunction-information storing object 340 has the malfunction-information name of "THROTTLE HIGH ABNORMAL SHEET" (or simply referred to as "THROTTLE HIGH ABNORM.SHEET"). Furthermore, a malfunction-information storing object 350 has the malfunction-information name of "THROTTLE LOW ABNORMAL SHEET" (or simply referred to as "THROTTLE LOW ABNORM. SHEET"). These five malfunction-information storing objects 310-350 are simply referred to as the first to fifth malfunction-information storing objects 310-350, respectively, for the sake of clarity.

As shown in FIG. 5, each one of the first to fifth malfunction-information storing objects 310-350 stores the corresponding malfunction information as well as the corresponding relationship information (or simply referred to as "REL.") indicative of the relationship between the malfunction information and the control instruction. The malfunction information is stored by the malfunction-information managing object 200 and indicates a current malfunction level. For example, the malfunction information of the first malfunction-information storing object 310 is stored as "temporarily abnormal" (or simply referred to as "TEMP.ABNORM."), and the malfunction information of the second malfunction-information storing object 320 is stored as "normal" (or simply referred to as "NORM."). Similarly, the malfunction information of the third malfunction-information

storing object 330 is stored as "abnormal" (or simply referred to as "ABNORM."), and the malfunction information of the fourth malfunction-information storing object 340 is stored as "normal". Furthermore, the malfunction information of the fifth malfunction-information storing object 350 is stored as "temporarily abnormal".

Types of malfunction information and the corresponding control operations are indicated in an upper row and in a lower row, respectively, in the relationship information. Thus, upon receiving the control instruction retrieving request from the malfunction-information managing object 200, the malfunction-information storing object 300 selects the corresponding control instruction based on the stored malfunction information and outputs it.

Next, the MIL response process S1, the MIL information output process S2 and the control instruction output process S3 will be described in greater detail for the purpose of promoting an understanding of the operations of the objects 200-400.

First, the MIL response process S1 will be described with reference to a flowchart shown in FIG. 6. This flowchart shows the MIL response process that is carried out by the MIL controlling object 400 when the MIL state renewal request is received from the PF 500.

First, at step (hereinafter, "step" is simply referred to as "S") 100, the MIL controlling object 400 requests the MIL information to the malfunction-information managing object 200. In response to this request, the malfunction-information

managing object 200 outputs the MIL information. When the MIL information is outputted, control moves to S110.

At S110, the vehicle information is acquired. One example of the vehicle information is on/off information of the ignition key.

Next, at S120, it is determined whether a lighting-on condition of the MIL 25 is satisfied based on the MIL information and the vehicle information. If it is determined that the lighting-on condition of the MIL 25 is satisfied (S120: YES), control moves to S130. At S130, a lighting-on instruction is outputted as the MIL response, and the MIL response process ends. On the other hand, if it is determined that the lighting-on condition of the MIL 25 is not satisfied (S120: NO), control moves to S140.

At S140, it is determined whether a flashing condition of the MIL 25 is satisfied based on the MIL information and the vehicle information. If it is determined that the flashing condition is satisfied (S140: YES), control moves to S150. At S150, a flashing instruction is outputted as the MIL response, and the MIL response process ends. On the other hand, if the flashing condition is not satisfied (S140: NO), control moves to S160.

At S160, it is determined whether a lighting-off condition of the MIL 125 is satisfied based on the MIL information and the vehicle information. If it is determined that the lighting-off condition is satisfied (S160: YES), control moves to S170. At S170, a lighting-off instruction is outputted as the MIL response,

and the MIL response process ends. On the other hand, if it is determined that the lighting-off condition is not satisfied (S160: NO), control skips S170, and the MIL response process ends.

5           Next, the MIL information output process S2 will be described with reference to FIG. 7.

FIG. 7 is a flowchart showing the MIL information output process S2 executed by the malfunction-information managing object 200. The MIL information output process S2 is executed when the MIL information request is received from the MIL controlling object 400.

10  
15  
First, at S200, the malfunction-information managing object 200 requests each malfunction-information storing object 300 to retrieve the corresponding control instruction. In response to this request, each malfunction-information storing object 300 outputs the control instruction. When the control instruction is outputted, control moves to S210.

20           At S210, it is determined whether all the malfunction-information storing objects 300 have received the control instruction retrieving request. For example, if there are five malfunction-information storing objects, namely, the first to fifth malfunction-information storing objects 310-350, as shown in FIG. 5, it is determined whether all the five malfunction-information storing objects 310-350 have received the control instruction retrieving request. If it is determined that all the malfunction-information storing objects 300 have received the control instruction retrieving request (S210: YES),



control moves to S220. On the other hand, if it is determined that there is any malfunction-information storing object 300 that has not received the control instruction retrieving request (S210: NO), control returns to S200 to repeat the same.

5           At S220, the MIL information is determined. In this operation, the control instruction of a higher priority outputted from each malfunction-information storing object 300 is selectively determined as the MIL information. As mentioned above, in the present embodiment, the control instructions of the MIL 25 include three types of control instructions, namely, "flashing", "lighting-on" and "lighting-off". Among these instructions, a priority level decreases in the following order: "flashing", "lighting-on" and "lighting-off".

10  
15  
20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150  
155  
160  
165  
170  
175  
180  
185  
190  
195  
200  
205  
210  
215  
220  
225  
230  
235  
240  
245  
250  
255  
260  
265  
270  
275  
280  
285  
290  
295  
300  
305  
310  
315  
320  
325  
330  
335  
340  
345  
350  
355  
360  
365  
370  
375  
380  
385  
390  
395  
400  
405  
410  
415  
420  
425  
430  
435  
440  
445  
450  
455  
460  
465  
470  
475  
480  
485  
490  
495  
500  
505  
510  
515  
520  
525  
530  
535  
540  
545  
550  
555  
560  
565  
570  
575  
580  
585  
590  
595  
600  
605  
610  
615  
620  
625  
630  
635  
640  
645  
650  
655  
660  
665  
670  
675  
680  
685  
690  
695  
700  
705  
710  
715  
720  
725  
730  
735  
740  
745  
750  
755  
760  
765  
770  
775  
780  
785  
790  
795  
800  
805  
810  
815  
820  
825  
830  
835  
840  
845  
850  
855  
860  
865  
870  
875  
880  
885  
890  
895  
900  
905  
910  
915  
920  
925  
930  
935  
940  
945  
950  
955  
960  
965  
970  
975  
980  
985  
990  
995  
1000  
1005  
1010  
1015  
1020  
1025  
1030  
1035  
1040  
1045  
1050  
1055  
1060  
1065  
1070  
1075  
1080  
1085  
1090  
1095  
1100  
1105  
1110  
1115  
1120  
1125  
1130  
1135  
1140  
1145  
1150  
1155  
1160  
1165  
1170  
1175  
1180  
1185  
1190  
1195  
1200  
1205  
1210  
1215  
1220  
1225  
1230  
1235  
1240  
1245  
1250  
1255  
1260  
1265  
1270  
1275  
1280  
1285  
1290  
1295  
1300  
1305  
1310  
1315  
1320  
1325  
1330  
1335  
1340  
1345  
1350  
1355  
1360  
1365  
1370  
1375  
1380  
1385  
1390  
1395  
1400  
1405  
1410  
1415  
1420  
1425  
1430  
1435  
1440  
1445  
1450  
1455  
1460  
1465  
1470  
1475  
1480  
1485  
1490  
1495  
1500  
1505  
1510  
1515  
1520  
1525  
1530  
1535  
1540  
1545  
1550  
1555  
1560  
1565  
1570  
1575  
1580  
1585  
1590  
1595  
1600  
1605  
1610  
1615  
1620  
1625  
1630  
1635  
1640  
1645  
1650  
1655  
1660  
1665  
1670  
1675  
1680  
1685  
1690  
1695  
1700  
1705  
1710  
1715  
1720  
1725  
1730  
1735  
1740  
1745  
1750  
1755  
1760  
1765  
1770  
1775  
1780  
1785  
1790  
1795  
1800  
1805  
1810  
1815  
1820  
1825  
1830  
1835  
1840  
1845  
1850  
1855  
1860  
1865  
1870  
1875  
1880  
1885  
1890  
1895  
1900  
1905  
1910  
1915  
1920  
1925  
1930  
1935  
1940  
1945  
1950  
1955  
1960  
1965  
1970  
1975  
1980  
1985  
1990  
1995  
2000  
2005  
2010  
2015  
2020  
2025  
2030  
2035  
2040  
2045  
2050  
2055  
2060  
2065  
2070  
2075  
2080  
2085  
2090  
2095  
2100  
2105  
2110  
2115  
2120  
2125  
2130  
2135  
2140  
2145  
2150  
2155  
2160  
2165  
2170  
2175  
2180  
2185  
2190  
2195  
2200  
2205  
2210  
2215  
2220  
2225  
2230  
2235  
2240  
2245  
2250  
2255  
2260  
2265  
2270  
2275  
2280  
2285  
2290  
2295  
2300  
2305  
2310  
2315  
2320  
2325  
2330  
2335  
2340  
2345  
2350  
2355  
2360  
2365  
2370  
2375  
2380  
2385  
2390  
2395  
2400  
2405  
2410  
2415  
2420  
2425  
2430  
2435  
2440  
2445  
2450  
2455  
2460  
2465  
2470  
2475  
2480  
2485  
2490  
2495  
2500  
2505  
2510  
2515  
2520  
2525  
2530  
2535  
2540  
2545  
2550  
2555  
2560  
2565  
2570  
2575  
2580  
2585  
2590  
2595  
2600  
2605  
2610  
2615  
2620  
2625  
2630  
2635  
2640  
2645  
2650  
2655  
2660  
2665  
2670  
2675  
2680  
2685  
2690  
2695  
2700  
2705  
2710  
2715  
2720  
2725  
2730  
2735  
2740  
2745  
2750  
2755  
2760  
2765  
2770  
2775  
2780  
2785  
2790  
2795  
2800  
2805  
2810  
2815  
2820  
2825  
2830  
2835  
2840  
2845  
2850  
2855  
2860  
2865  
2870  
2875  
2880  
2885  
2890  
2895  
2900  
2905  
2910  
2915  
2920  
2925  
2930  
2935  
2940  
2945  
2950  
2955  
2960  
2965  
2970  
2975  
2980  
2985  
2990  
2995  
3000  
3005  
3010  
3015  
3020  
3025  
3030  
3035  
3040  
3045  
3050  
3055  
3060  
3065  
3070  
3075  
3080  
3085  
3090  
3095  
3100  
3105  
3110  
3115  
3120  
3125  
3130  
3135  
3140  
3145  
3150  
3155  
3160  
3165  
3170  
3175  
3180  
3185  
3190  
3195  
3200  
3205  
3210  
3215  
3220  
3225  
3230  
3235  
3240  
3245  
3250  
3255  
3260  
3265  
3270  
3275  
3280  
3285  
3290  
3295  
3300  
3305  
3310  
3315  
3320  
3325  
3330  
3335  
3340  
3345  
3350  
3355  
3360  
3365  
3370  
3375  
3380  
3385  
3390  
3395  
3400  
3405  
3410  
3415  
3420  
3425  
3430  
3435  
3440  
3445  
3450  
3455  
3460  
3465  
3470  
3475  
3480  
3485  
3490  
3495  
3500  
3505  
3510  
3515  
3520  
3525  
3530  
3535  
3540  
3545  
3550  
3555  
3560  
3565  
3570  
3575  
3580  
3585  
3590  
3595  
3600  
3605  
3610  
3615  
3620  
3625  
3630  
3635  
3640  
3645  
3650  
3655  
3660  
3665  
3670  
3675  
3680  
3685  
3690  
3695  
3700  
3705  
3710  
3715  
3720  
3725  
3730  
3735  
3740  
3745  
3750  
3755  
3760  
3765  
3770  
3775  
3780  
3785  
3790  
3795  
3800  
3805  
3810  
3815  
3820  
3825  
3830  
3835  
3840  
3845  
3850  
3855  
3860  
3865  
3870  
3875  
3880  
3885  
3890  
3895  
3900  
3905  
3910  
3915  
3920  
3925  
3930  
3935  
3940  
3945  
3950  
3955  
3960  
3965  
3970  
3975  
3980  
3985  
3990  
3995  
4000  
4005  
4010  
4015  
4020  
4025  
4030  
4035  
4040  
4045  
4050  
4055  
4060  
4065  
4070  
4075  
4080  
4085  
4090  
4095  
4100  
4105  
4110  
4115  
4120  
4125  
4130  
4135  
4140  
4145  
4150  
4155  
4160  
4165  
4170  
4175  
4180  
4185  
4190  
4195  
4200  
4205  
4210  
4215  
4220  
4225  
4230  
4235  
4240  
4245  
4250  
4255  
4260  
4265  
4270  
4275  
4280  
4285  
4290  
4295  
4300  
4305  
4310  
4315  
4320  
4325  
4330  
4335  
4340  
4345  
4350  
4355  
4360  
4365  
4370  
4375  
4380  
4385  
4390  
4395  
4400  
4405  
4410  
4415  
4420  
4425  
4430  
4435  
4440  
4445  
4450  
4455  
4460  
4465  
4470  
4475  
4480  
4485  
4490  
4495  
4500  
4505  
4510  
4515  
4520  
4525  
4530  
4535  
4540  
4545  
4550  
4555  
4560  
4565  
4570  
4575  
4580  
4585  
4590  
4595  
4600  
4605  
4610  
4615  
4620  
4625  
4630  
4635  
4640  
4645  
4650  
4655  
4660  
4665  
4670  
4675  
4680  
4685  
4690  
4695  
4700  
4705  
4710  
4715  
4720  
4725  
4730  
4735  
4740  
4745  
4750  
4755  
4760  
4765  
4770  
4775  
4780  
4785  
4790  
4795  
4800  
4805  
4810  
4815  
4820  
4825  
4830  
4835  
4840  
4845  
4850  
4855  
4860  
4865  
4870  
4875  
4880  
4885  
4890  
4895  
4900  
4905  
4910  
4915  
4920  
4925  
4930  
4935  
4940  
4945  
4950  
4955  
4960  
4965  
4970  
4975  
4980  
4985  
4990  
4995  
5000  
5005  
5010  
5015  
5020  
5025  
5030  
5035  
5040  
5045  
5050  
5055  
5060  
5065  
5070  
5075  
5080  
5085  
5090  
5095  
5100  
5105  
5110  
5115  
5120  
5125  
5130  
5135  
5140  
5145  
5150  
5155  
5160  
5165  
5170  
5175  
5180  
5185  
5190  
5195  
5200  
5205  
5210  
5215  
5220  
5225  
5230  
5235  
5240  
5245  
5250  
5255  
5260  
5265  
5270  
5275  
5280  
5285  
5290  
5295  
5300  
5305  
5310  
5315  
5320  
5325  
5330  
5335  
5340  
5345  
5350  
5355  
5360  
5365  
5370  
5375  
5380  
5385  
5390  
5395  
5400  
5405  
5410  
5415  
5420  
5425  
5430  
5435  
5440  
5445  
5450  
5455  
5460  
5465  
5470  
5475  
5480  
5485  
5490  
5495  
5500  
5505  
5510  
5515  
5520  
5525  
5530  
5535  
5540  
5545  
5550  
5555  
5560  
5565  
5570  
5575  
5580  
5585  
5590  
5595  
5600  
5605  
5610  
5615  
5620  
5625  
5630  
5635  
5640  
5645  
5650  
5655  
5660  
5665  
5670  
5675  
5680  
5685  
5690  
5695  
5700  
5705  
5710  
5715  
5720  
5725  
5730  
5735  
5740  
5745  
5750  
5755  
5760  
5765  
5770  
5775  
5780  
5785  
5790  
5795  
5800  
5805  
5810  
5815  
5820  
5825  
5830  
5835  
5840  
5845  
5850  
5855  
5860  
5865  
5870  
5875  
5880  
5885  
5890  
5895  
5900  
5905  
5910  
5915  
5920  
5925  
5930  
5935  
5940  
5945  
5950  
5955  
5960  
5965  
5970  
5975  
5980  
5985  
5990  
5995  
6000  
6005  
6010  
6015  
6020  
6025  
6030  
6035  
6040  
6045  
6050  
6055  
6060  
6065  
6070  
6075  
6080  
6085  
6090  
6095  
6100  
6105  
6110  
6115  
6120  
6125  
6130  
6135  
6140  
6145  
6150  
6155  
6160  
6165  
6170  
6175  
6180  
6185  
6190  
6195  
6200  
6205  
6210  
6215  
6220  
6225  
6230  
6235  
6240  
6245  
6250  
6255  
6260  
6265  
6270  
6275  
6280  
6285  
6290  
6295  
6300  
6305  
6310  
6315  
6320  
6325  
6330  
6335  
6340  
6345  
6350  
6355  
6360  
6365  
6370  
6375  
6380  
6385  
6390  
6395  
6400  
6405  
6410  
6415  
6420  
6425  
6430  
6435  
6440  
6445  
6450  
6455  
6460  
6465  
6470  
6475  
6480  
6485  
6490  
6495  
6500  
6505  
6510  
6515  
6520  
6525  
6530  
6535  
6540  
6545  
6550  
6555  
6560  
6565  
6570  
6575  
6580  
6585  
6590  
6595  
6600  
6605  
6610  
6615  
6620  
6625  
6630  
6635  
6640  
6645  
6650  
6655  
6660  
6665  
6670  
6675  
6680  
6685  
6690  
6695  
6700  
6705  
6710  
6715  
6720  
6725  
6730  
6735  
6740  
6745  
6750  
6755  
6760  
6765  
6770  
6775  
6780  
6785  
6790  
6795  
6800  
6805  
6810  
6815  
6820  
6825  
6830  
6835  
6840  
6845  
6850  
6855  
6860  
6865  
6870  
6875  
6880  
6885  
6890  
6895  
6900  
6905  
6910  
6915  
6920  
6925  
6930  
6935  
6940  
6945  
6950  
6955  
6960  
6965  
6970  
6975  
6980  
6985  
6990  
6995  
7000  
7005  
7010  
7015  
7020  
7025  
7030  
7035  
7040  
7045  
7050  
7055  
7060  
7065  
7070  
7075  
7080  
7085  
7090  
7095  
7100  
7105  
7110  
7115  
7120  
7125  
7130  
7135  
7140  
7145  
7150  
7155  
7160  
7165  
7170  
7175  
7180  
7185  
7190  
7195  
7200  
7205  
7210  
7215  
7220  
7225  
7230  
7235  
7240  
7245  
7250  
7255  
7260  
7265  
7270  
7275  
7280  
7285  
7290  
7295  
7300  
7305  
7310  
7315  
7320  
7325  
7330  
7335  
7340  
7345  
7350  
7355  
7360  
7365  
7370  
7375  
7380  
7385  
7390  
7395  
7400  
7405  
7410  
7415  
7420  
7425  
7430  
7435  
7440  
7445  
7450  
7455  
7460  
7465  
7470  
7475  
7480  
7485  
7490  
7495  
7500  
7505  
7510  
7515  
7520  
7525  
7530  
7535  
7540  
7545  
7550  
7555  
7560  
7565  
7570  
7575  
7580  
7585  
7590  
7595  
7600  
7605  
7610  
7615  
7620  
7625  
7630  
7635  
7640  
7645  
7650  
7655  
7660  
7665  
7670  
7675  
7680  
7685  
7690  
7695  
7700  
7705  
7710  
7715  
7720  
7725  
7730  
7735  
7740  
7745  
7750  
7755  
7760  
7765  
7770  
7775  
7780  
7785  
7790  
7795  
7800  
7805  
7810  
7815  
7820  
7825  
7830  
7835  
7840  
7845  
7850  
7855  
7860  
7865  
7870  
7875  
7880  
7885  
7890  
7895  
7900  
7905  
7910  
7915  
7920  
7925  
7930  
7935  
7940  
7945  
7950  
7955  
7960  
7965  
7970  
7975  
7980  
7985  
7990  
7995  
8000  
8005  
8010  
8015  
8020  
8025  
8030  
8035  
8040  
8045  
8050  
8055  
8060  
8065  
8070  
8075  
8080  
8085  
8090  
8095  
8100  
8105  
8110  
8115  
8120  
8125  
8130  
8135  
8140  
8145  
8150  
8155  
8160  
8165  
8170  
8175  
8180  
8185  
8190  
8195  
8200  
8205  
8210  
8215  
8220  
8225  
8230  
8235  
8240  
8245  
8250  
8255  
8260  
8265  
8270  
8275  
8280  
8285  
8290  
8295  
8300  
8305  
8310  
8315  
8320  
8325  
8330  
8335  
8340  
8345  
8350  
8355  
8360  
8365  
8370  
8375  
8380  
8385  
8390  
8395  
8400  
8405  
8410  
8415  
8420  
8425  
8430  
8435  
8440  
8445  
8450  
8455  
8460  
8465  
8470  
8475  
8480  
8485  
8490  
8495  
8500  
8505  
8510  
8515  
8520  
8525  
8530  
8535  
8540  
8545  
8550  
8555  
8560  
8565  
8570  
8575  
8580  
8585  
8590  
8595  
8600  
8605  
8610  
8615  
8620  
8625  
8630  
8635  
8640  
8645  
8650  
8655  
8660  
8665  
8670  
8675  
8680  
8685  
8690  
8695  
8700  
8705  
8710  
8715  
8720  
8725  
8730  
8735  
8740  
8745  
8750  
8755  
8760  
8765  
8770  
8775  
8780  
8785  
8790  
8795  
8800  
8805  
8810  
8815  
8820  
8825  
8830  
8835  
8840  
8845  
8850  
8855  
8860  
8865  
8870  
8875  
8880  
8885  
8890  
8895  
8900  
8905  
8910  
8915  
8920  
8925  
8930  
8935  
8940  
8945  
8950  
8955  
8960  
8965  
8970  
8975  
8980  
8985  
8990  
8995  
9000  
9005  
9010  
9015  
9020  
9025  
9030  
9035  
9040  
9045  
9050  
9055  
9060  
9065  
9070  
9075  
9080  
9085  
9090  
9095  
9100  
9105  
9110  
9115  
9120  
9125  
9130  
9135  
9140  
9145  
9150  
9155  
9160  
9165  
9170  
9175  
9180  
9185  
9190  
9195  
9200  
9205  
9210  
9215  
9220  
9225  
9230  
9235  
9240  
9245  
9250  
9255  
9260  
9265  
9270  
9275  
9280  
9285  
9290  
9295  
9300  
9305  
9310  
9315  
9320  
9325  
9330  
9335  
9340  
9345  
9350  
9355  
9360  
9365  
9370  
9375  
9380  
9385  
9390  
9395  
9400  
9405  
9410  
9415  
9420  
9425  
9430  
9435  
9440  
9445  
9450  
9455  
9460  
9465  
9470  
9475  
9480  
9485  
9490  
9495  
9500  
9505  
9510  
9515  
9520  
9525  
9530  
9535  
9540  
9545  
9550  
9555  
9560  
9565  
9570  
9575  
9580  
9585  
9590  
9595  
9600  
9605  
9610  
9615  
9620  
9625  
9630  
9635  
9640  
9645  
9650  
9655  
9660  
9665  
9670  
9675  
9680  
9685  
9690  
9695  
9700  
9705  
9710  
9715  
9720  
9725  
9730  
9735  
9740  
9745  
9750  
9755  
9760  
9765  
9770  
9775  
9780  
9785  
9790  
9795  
9800  
9805  
9810  
9815  
9820  
9825  
9830  
9835  
9840  
9845  
9850  
9855  
9860  
9865  
9870  
9875  
9880  
9885  
9890  
9895  
9900  
9905  
9910  
9915  
9920  
9925  
9930  
9935  
9940  
9945  
9950  
9955  
9960  
9965  
9970  
9975  
9980  
9985  
9990  
9995  
10000  
10005  
10010  
10015  
10020  
10025  
10030  
10035  
10040  
10045  
10050  
10055  
10060  
10065  
10070  
10075  
10080  
10085  
10090  
10095  
10100  
10105  
10110  
10115  
10120  
10125  
10130  
10135  
10140  
10145  
10150  
10155  
10160  
10165  
10170  
10175  
10180  
10185  
10190  
10195  
10200  
10205  
10210  
10215  
10220  
10225  
10230  
10235  
10240  
10

retrieves "temporarily abnormal" as the malfunction information.

Next, at S310, reference is made to the relationship information. Then, at S320, the control instruction corresponding to the malfunction information retrieved at S300 is specified. For example, since the malfunction information of the first malfunction-information storing object 310 shown in FIG. 5 is "temporarily abnormal", the first malfunction-information storing object 310 specifies "lighting-off" as the control instruction by referring to the relationship information.

Thereafter, at S330, the control instruction specified at S320 is outputted to the malfunction-information managing object 200.

Advantages of the objects 200-400 arranged in the above manner will be described below.

The present embodiment is based on the following fact. That is, the logic for specifying the control instruction of the MIL 25 based on the malfunction information needs to be constructed in view of the type of the diagnosis target. To satisfy this requirement, the adjustment logic for adjusting the result of the malfunction-information determination operation is implemented by the two objects. That is, the malfunction-information storing object 300 specifies the control instruction for the malfunction information (FIG. 8), and the malfunction-information managing object 200 adjusts the specified control instruction (S220 in FIG. 7) and outputs the

final MIL information (S230). As a result, even if any diagnosis target is changed, it is only required to change the corresponding malfunction-information storing object 300, so that there is no need to change or modify the malfunction-information managing object 200. Thus, the reusability of the self-diagnosis program is improved, and the disadvantage discussed in the above section (1) can be dissolved.

Furthermore, in the present embodiment, the malfunction-information storing object 300 is prepared for each malfunction check item that corresponds to the diagnosis target. Thus, even if any diagnosis target is changed, it is only required to change or add the corresponding malfunction-information storing object 300. This allows improvement in the reusability of the self-diagnosis program.

Furthermore, the malfunction information indicative of "normal", "temporarily abnormal" or "abnormal" is stored for each malfunction check item, which corresponds to the diagnosis target, by the process that is triggered by the malfunction detection request outputted from the PF 500. Furthermore, the MIL control operation is carried out in the other process that is triggered by the MIL state renewal request. More specifically, the MIL controlling object 400 outputs the MIL information request when the MIL state renewal request acting as the trigger is received from the PF 500. In response to the MIL information request, the malfunction-information managing object 200 outputs the MIL information (FIG. 4). Thus, the MIL control operation can be carried out irrespective of the timing for

executing the malfunction-information determination operation. As a result, even if the diagnosis target is changed, and thereby the timing for executing the malfunction-information determination operation is changed, there is no need to change or modify the malfunction-information managing object 200 that outputs the MIL information. Because of this reason, the reusability of the self-diagnosis program is improved, and the disadvantage discussed in the above section (2) can be dissolved.

Furthermore, the adjustment of the result of the malfunction-information determination operation and the MIL control operation are carried out by the different objects, i.e., by the malfunction-information managing object 200, which outputs the MIL information, and the MIL controlling object 400, which controls the MIL, respectively. Thus, even if the diagnosis target is changed, there is a higher possibility that the MIL controlling object 400 is reused. On the other hand, if only the logic for executing the MIL control operation needs to be changed, the malfunction-information managing object 200 can be reused without modifying it. As a result, the reusability of the self-diagnosis program is improved, and the disadvantage discussed in the above section (3) can be dissolved.

Here, the malfunction-information managing object 200 of the present embodiment corresponds to "the malfunction-information managing object" of the present invention, and the malfunction-information storing object 300 corresponds to "the malfunction-information storing object" of the present invention. Also, the MIL controlling object 400

corresponds to "the MIL controlling object" of the present invention.

The self-diagnosis program of the vehicular control device can be provided as the program that is executed by the computer system side. Such a program may be stored in a computer readable recording medium, such as a FD, an MO, a CD-ROM, a DVD, a hard disk or the like and can be loaded to the computer system to execute it therein. Furthermore, a ROM or a backup RAM can be used as the computer readable recording medium to store the program and can be provided in the computer system.

Additional advantages and modifications will readily occur to those skilled in the art. The invention in its broader terms is therefore, not limited to the specific details, representative apparatus, and illustrative examples shown and described.